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Development of a Large-Scale Laboratory Facility for Longshore Sediment Transport Research

by Jimmy E. Fowler, Julie D. Rosati,
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Introduction

If you can't go to the beach, then bring the beach to you! Researchers at the U.S. Army Corps of Engineers (USACE) Waterways Experiment Station's Coastal Engineering Research Center (CERC) are effectively

"bringing the beach" to Vicksburg, Mississippi, through the Large-Scale Laboratory Investigation of Longshore Sediment Transport (LST) work unit. CERC is conducting this research to improve capabilities for predicting local and total LST rates and to evaluate errors associated with these pre-

dictions. To achieve this goal, CERC is developing a mobile-bed Longshore Sediment Transport Facility (LSTF). Figure 1 is an artist's rendition of the LSTF as it will look when fully operational. The focus of this work unit will be a physical modeling study consisting of a series of well-instrumented, mid- to large-scale laboratory experiments in the LSTF (including several sand grain sizes, under a wide range of wave and current conditions). The other portion of the effort will involve using the laboratory data, combined with existing field data, to develop/improve local and total LST predictive relationships. A team of experts in the areas of physical modeling, numerical modeling, and nearshore hydrodynamic and alongshore sediment transport has been assembled to enhance the probability for success in this extremely complex study.

Background

Methods for predicting LST are limited both by fundamental knowledge of sediment transport processes and by the field and laboratory data sets on which these relationships are based. The so-called "CERC formula" (*Shore Protection Manual (SPM)* 1984) has been regularly applied

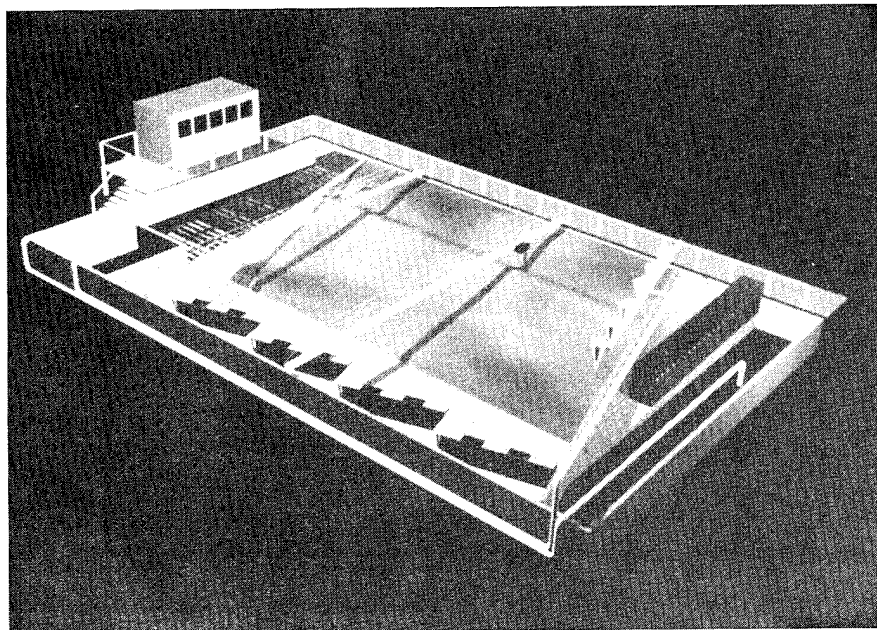
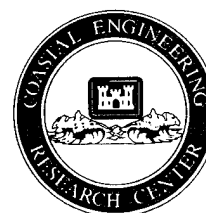


Figure 1. Artist's rendition of the Longshore Sediment Transport Facility



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to estimate total LST rates, based on field data from impoundment and tracer studies conducted at five sites along the U.S. coastline (four on the Pacific and the fifth on the Atlantic, by no means an exhaustive or complete representation). This formula, which has an accuracy estimated conservatively at ± 50 percent (SPM 1984), does not include several factors that logically influence LST (e.g. grain size, bottom friction, beach profile shape, breaking wave type, local wave dissipation, and magnitude and distribution of the longshore current). In a critical review of the CERC formula, Bodge and Kraus (1991) estimated that impoundment studies may be in error by as much as a factor of two (due to spurious impoundment, survey inaccuracies, directional wave data resolution, etc.), and tracer studies in error up to a factor of four (due to limitations in sampling methodology). In practice, a simple (e.g., rectangular) cross-shore distribution of LST is typically assumed in estimations of sediment bypassing around

groins or jetties or sediment transport over a weir section.

The design and performance of four other longshore current and LST physical modeling facilities have been investigated to aid in the LSTF design: (1) the movable-bed facility at Queen's University in Ontario, Canada, used to conduct fundamental LST experiments (Kamphuis 1991); (2) a larger movable-bed facility at the Canadian National Research Council, used to conduct LST experiments including groins and seawalls (Badiei et al. 1994); (3) the Coastal Research Facility in Wallingford, United Kingdom, which presently has hydrodynamic capability only, but will eventually include sediment transport (Whitehouse and Hotchkiss 1994); and (4) the Delft Hydraulics facility in The Netherlands, which was used to study longshore current instabilities (hydrodynamic capability only) (Reniers et al. 1994).

Purpose

The LSTF will be used to produce a set of high quality mid- to large-scale LST data for a wide range of incident wave conditions. This data set will be used to extend existing field and laboratory data, and ultimately improve predictive relationships used to estimate local and total LST.

Design of the LSTF

Laboratory tests in support of this study will be conducted in CERC's newest 3-D basin during the period 1996-1999. The reinforced concrete basin is located in the Robert Y. Hudson building and is presently bordered by the General Studies Basin as shown in Figure 2. The LSTF is being constructed in a 30-m by 5-m section of a basin which has overall dimensions of 30 m by 80 m by 1.4 m. When fully operational, the facility will simulate wave, current, and sediment transport at the boundaries of the active beach at geometric scales on the order of 1:10, model to prototype.

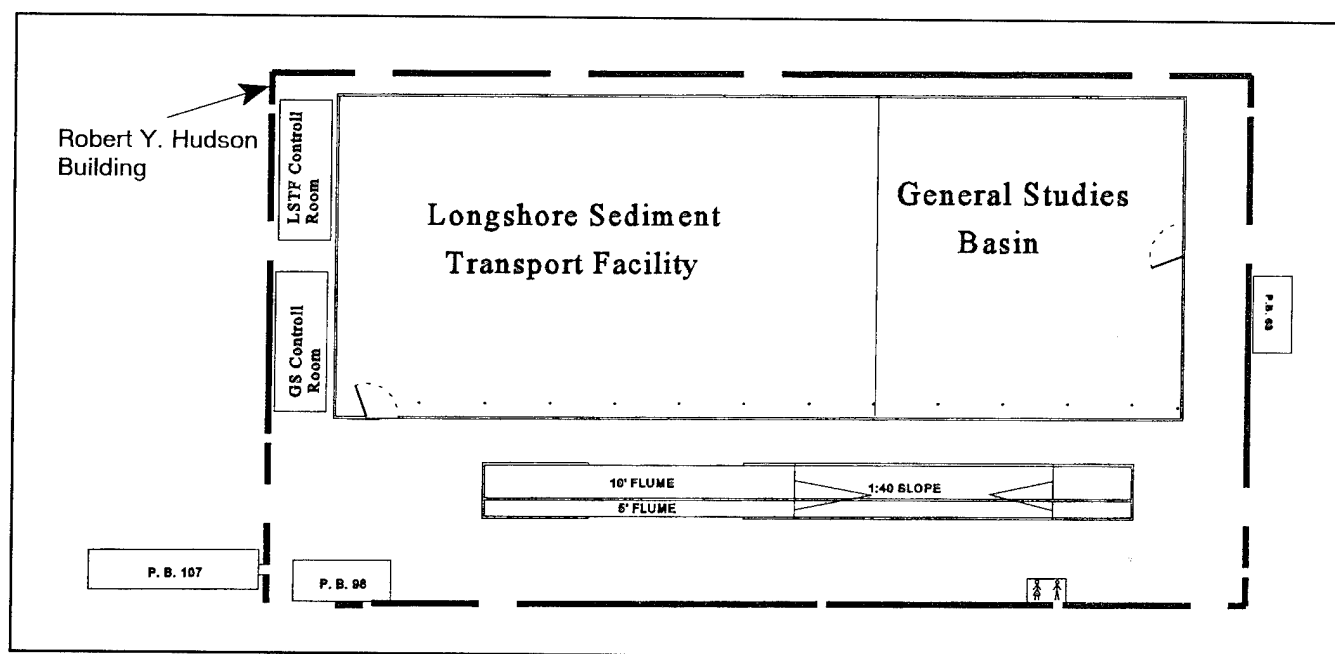


Figure 2. Plan view of 3-D basin to be used in large-scale laboratory investigation of longshore sediment transport

The LSTF will have a mobile-bed beach approximately 30 m in length as shown in Figure 3. As shown in the figure, the "working beach region" will be about 20 m in length, less than half of the total length of the LSTF basin. The remainder is required to support current and sediment handling systems used to produce desired cross-shore distributions of longshore current and sediment transport at the updrift end of the beach and recirculate flow and sediment from the downdrift end of the beach. If plans proceed as envisioned, the LSTF eventually will be extended to include the entire 80-m length of the basin. This increase will be needed to accommodate the highest wave

energy conditions planned for the study.

Wave Generation. Wave machines arranged in sawtooth fashion as shown in Figure 3, capable of generating irregular waves with 0.4-m significant wave height at maximum operating conditions (wave period ≈ 2.5 sec with 0.9 m depth), will be used in the LSTF. These wave machines were designed specially for this study and are being constructed by MTS Systems Corporation of Minneapolis, MN. Each wave machine will be powered by a state-of-the-art high performance servo-electric drive system. This configuration will virtually eliminate the possibility of oil contamination of model sediments and will significantly re-

duce the noise level associated with conventional servo-hydraulic systems. The wave machines will be controlled by a personal computer (PC) and will be operational by January 1996. Wave guides will be used to train the waves onto the beach.

Longshore Current Generation. A longshore current control system will be incorporated into the design of wave guides to ensure proper cross-shore distribution of the longshore current. The system will use a bank of modular porous wave guides located in the active inflow region shown in Figure 3. A pump and a series of control valves will be used to adjust the hydraulic head in each compartment to control the magnitude

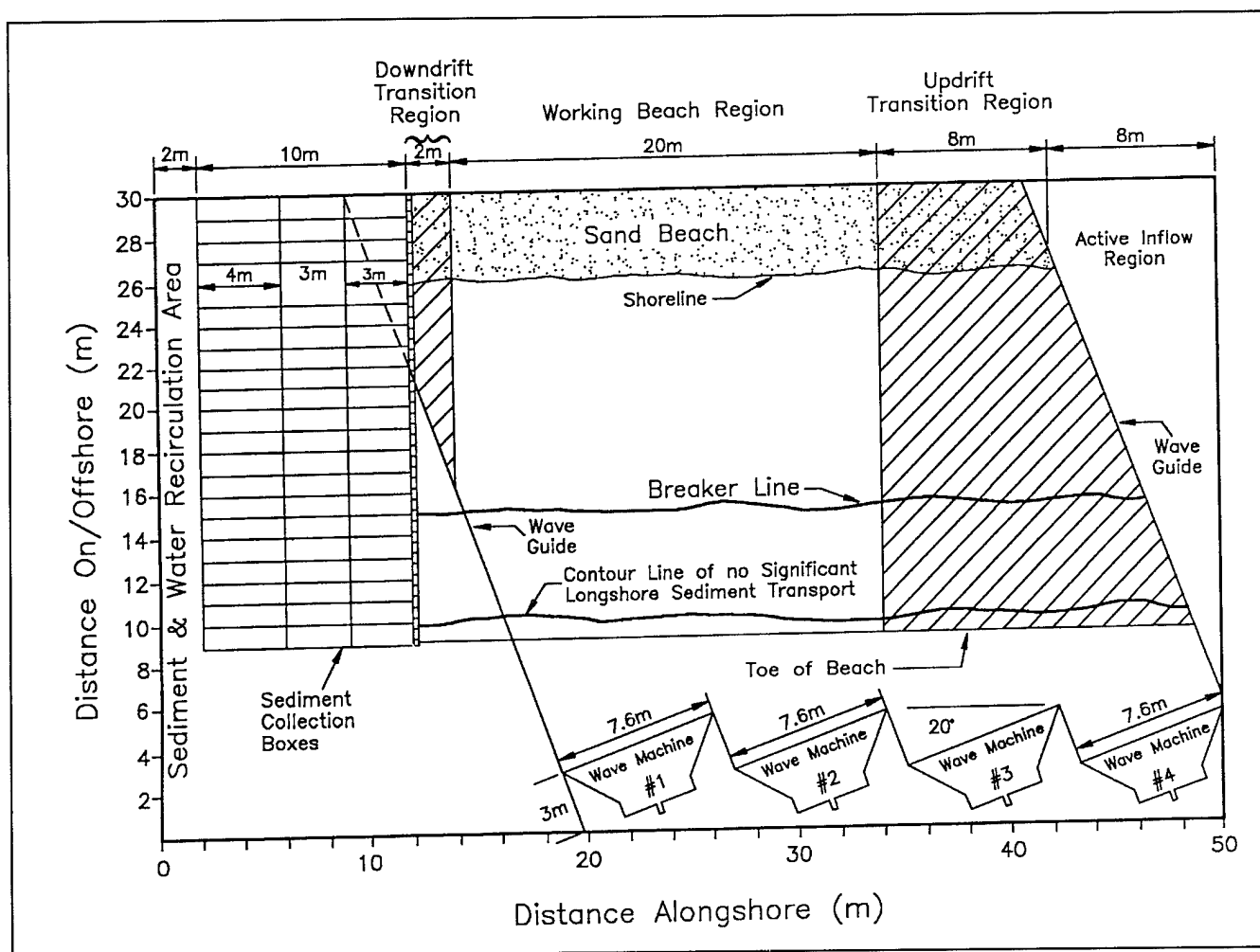


Figure 3. Plan view of LSTF

and cross-shore distribution of the longshore currents.

Sediment Handling System.

A sediment feeder system will be designed and constructed to manage the large volume of model sediments being transported along the beach. The system will consist of three sub-systems: (1) mechanical sediment collection boxes (traps) will measure the magnitude and cross-shore distribution of sediments transported beyond the downdrift boundary of the "working beach region," (2) a sediment circulation system, composed of a series of slurry pumps and pipes, will be used to dredge the sediment traps and circulate the model sediment back to the updrift end of the beach, and (3) a sediment feeding system, consisting of a series of hydrocyclones or mechanical feeders, will insert sediment at various locations in the "updrift transition region" of the beach. The hydrocyclone inputs will be adjusted (volume and location) to minimize efforts required to create and maintain equilibrium conditions within the test section. The function of these three subsystems is to effectively create a "closed loop" system which artificially simulates an infinitely long beach within the finite physical constraints of a wave basin. Designing this system so that these "human" adjustments do not adversely affect the natural physical processes being simulated within the working beach region is one of the most challenging problems in designing the LSTF.

Data Acquisition

An instrumentation bridge will traverse the working beach region to allow detailed measurements of waves, currents, sediment concentration, and beach profile evolution. The bridge will serve as a

platform for mounting wave gauges, current meters, optical backscatter sensors, and a bottom sensing profiling device. During nontesting periods, the bridge also will function as an observation platform and walkway. A PC-based Automated Data Acquisition and Control System (PADACS) will be used to collect data from various gauges and sensors employed during the study. The PADACS will handle at least 64 data channels, and additional capacity will be added as subsequent requirements are identified.

Wave Data. Wave gauges will be used at various locations across the profile to measure wave shoaling and decay. PADACS will be used to calibrate wave rods and collect wave height data.

Longshore Currents. Longshore current speed and direction will be measured at approximately ten locations along shore-perpendicular survey lines using Sontec Acoustic Doppler Velocimeters (ADV). All but two of these ADVs will be capable of simultaneously measuring all three velocity (x, y, and z) components. The other two will only measure the two horizontal axes and primarily will be used to measure velocities in shallow areas close to the shoreline and possibly in the swash zone.

Bathymetric Data. The basin floor corresponds to -0.9-m elevation with respect to the still-water level. Maximum dry beach elevation with 0.9 m of water depth is +0.47 m, so that the total potential modeled elevation from basin floor to top of beach is 1.37 m. An automated bathymetric survey system will be constructed during the second year of the project and will be designed to rapidly measure cross-shore profiles with water in the basin. Profiles will be taken at various time intervals during

movable-bed tests to document profile evolution, alongshore uniformity of beach profiles, and equilibrium conditions.

Sediment Transport Rates.

The cross-shore distribution of total longshore sediment transport rate will be measured using mechanical traps located at the downdrift edge of the "working beach region." These traps will be part of a sediment handling system that will be incorporated into the movable-bed tests scheduled for 1997-1999.

Documentation of Tests. A remote-controlled video camera will be positioned at an elevated vantage point to document overall test procedures. A second video camera will be used to document additional items of interest such as wave runup, sediment movement, and operation of the sediment feeder/collector system.

Summary

When completed and fully operational, the LSTF will be unique in the United States, and capable of producing waves, currents, and sediment transport magnitudes at large scales (as close to prototype dimensions as possible). One of the primary objectives is to produce submerged LST rates as high as 2.8 kg/s (10,000 kg/hr or 88,500 m³/yr), which is almost two orders of magnitude larger than what has been previously generated in the laboratory (Kamphuis 1991). Transport rates up to this maximum are targeted to fill the gap between existing laboratory and field data sets, and to complement other field-oriented LST research at CERC. The LSTF experimental test series, which will be conducted between 1996 and 1999, will produce a wide range of wave, current, and sediment transport magnitudes. Published relationships of LST

rates with wave height, wave period, incident wave angle, a median grain size, and typical median grain sizes used for USACE beach nourishment projects were considered when developing the experimental test series. The final products from this effort will be improved methods for estimating longshore sediment transport rates and cross-shore distributions and a better definition of limitations of existing predictive relationships. Funding for development of the LSTF is sponsored by the Coastal Research and Development Program through the Army Corps of Engineers.

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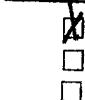
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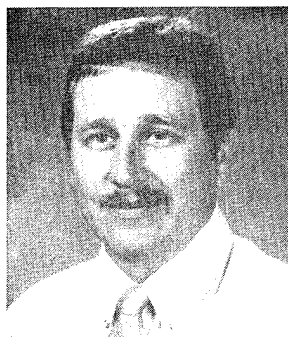


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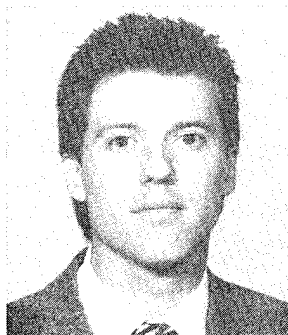
Dr. Jimmy E. Fowler is a Hydraulic Research Engineer in the Wave Processes Branch, Wave Dynamics Division, Coastal Engineering Research Center, WES. He received his B.S., M.E. and Ph.D. degrees from Clemson University. Dr. Fowler has been previously employed by the U.S. Army Engineer District, Charleston, and was a visiting professor at Clemson University. Since joining CERC in 1983, he has worked on numerous physical modeling, coastal erosion, and sediment transport studies. He is a member of the American Society of Civil Engineers, the Coastal Society, Society of American Military Engineers, and the Mississippi Academy of Science. He is an Engineer Officer with the U.S. Army Reserve.



Julie D. Rosati is a Research Hydraulic Engineer in the Coastal Processes Branch, Research Division, CERC, WES. She holds B.S. and M.S. degrees in Civil Engineering from Northwestern and Mississippi State Universities, respectively. Ms. Rosati began working at CERC in 1982 through a work-study program, and is presently a co-PI on two team research projects which are focused on improving predictions of surf zone sediment transport and the effects of inlets on adjacent beaches. She is a Registered Professional Engineer in the State of Mississippi.



David G. Hamilton is a Coastal Engineer working under contract to the Coastal Processes Branch, Research Division, CERC, WES. Mr. Hamilton's previous research experience involved investigating the physical processes of sediment transport near groins and seawalls while working at Queen's University Coastal Engineering Research Laboratory and the Hydraulics Laboratory of the National Research Council of Canada. He has a B.Sc. in Civil Engineering and an M.Sc. in Civil Engineering (Coastal) from Queen's University at Kingston, Canada.



Jane M. Smith is a Research Hydraulic Engineer in the Coastal Processes Branch, Research Division, CERC, WES. Her research interests include wave-induced currents and wave transformation and breaking. She has a B.S. in Civil Engineering from South Dakota State University and an M.S. in Civil Engineering from Mississippi State University. She is a Registered Professional Engineer in the State of Mississippi.



Coastal Engineering Research Board

The 61st meeting of the Coastal Engineering Research Board (CERB) was held on 10 May 1995, in Galveston, TX. The CERB is Congressionally mandated to advise the Chief of Engineers on all matters related to coastal engineering. The Board meets twice a year in different geographical areas to obtain a better understanding of problems in the areas.

The Board is comprised of seven members. The President of the Board is MG Stanley G. Genega, Director of Civil Works. The other three military members are BG Ralph V. Locurcio, Commander, South Atlantic Division; BG Milton Hunter, Commander, North Atlantic Division; and BG Henry S. Miller, Jr., Commander, Pacific Ocean Division. The three civilian members are Dr. Paul D. Komar, Oregon State University; Dr. Robert G. Dean, University of Florida; and Dr. Edward K. Noda, Edward K. Noda and Associates, Inc., Honolulu, HI. COL Bruce K. Howard,

Commander of the U.S. Army Engineer Waterways Experiment Station, acts as the Executive Secretary of the CERB and is responsible for all administrative functions of the Board.

The theme of this meeting was "The Corps' Role in Coastal Zone Management." Mr. Charles Chesnutt from Headquarters, U.S. Army Corps of Engineers (HQUSACE), introduced the theme of the meeting and was the moderator on the panel "Coastal Zone Management." Speakers on the panel were Mr. Ira D. Young, Los Angeles District, who presented the historical Corps perspective; Mr. Joseph A. Uravitch, Office of Ocean and Coastal Resource Management, who presented the Federal perspective; Mr. Orville T. Magoon, Consultant, Middletown, CA, who presented the international perspective; Ms. Sally S. Davenport, Texas General Land Office, Austin, TX, who presented the Texas perspective; Mr. T. Neil McLellan, Galveston District, who presented

the Galveston District Coastal Zone Management coordination; Mr. Steven P. Valerius, Hollywood Marine, Houston, TX, who presented the Texas industry perspective; Mr. Ralph D. Cantral, Florida Coastal Management Program, Tallahassee, FL, who presented the Florida perspective; and Mr. David H. Lucas, Isle of Palms, SC, who presented the private property owner perspective.

Other presentations included a report on the Chief's Initiatives and Action Items by COL Howard; the status of the Coastal Research and Development Programs by Dr. William E. Roper, R&D Directorate, HQUSACE; a report on the CERB Task Force by BG Hunter and Dr. Dean; and a presentation entitled "Success of the Houston/Galveston Inter-agency Coordination Team" by Mr. Dalton H. Krueger of the Galveston District.

Proceedings of the meeting will be available. Point of contact is Ms. Sharon L. Hanks, WES, CERC, (601) 634-2004.

CERC Publications

Reports listed below having AD numbers can be purchased from the National Technical Information Service (NTIS), U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161; telephone (703) 487-4600. For those reports that do not have the AD number, the report can be obtained from the U.S. Army Engineer Waterways Experiment Station (601) 634-2571.

Miscellaneous Papers

MP CERC-94-5, NTIS No. AD A280 423, "Index and Bulk Parameters for Frequency-Direction Spectra Measured at CERC Field Research Facility, September 1990 to August 1991," Charles E. Long, Juliana Atmadja, May 1994.

A multiyear series of wind wave frequency-direction spectral measurements has been undertaken at the Field Research Facility of the Coastal Engineering Research Center, U.S. Army Engineer Waterways Experiment Station. Cross-spectra of surface-corrected signals from a spatial array of 15 bottom-mounted pressure sensors have been used in conjunction with an iterative maximum likelihood algorithm to estimate frequency-direction spectra in about 8 m of water, approximately 900 m offshore. This report provides an index of and describes a means of access to 1,973 spectral observations obtained from September 1990 to August 1991. This period represents the fifth year of data collection. In addition to a list of data collection start times, a set of bulk parameters is provided to characterize the observations. Included are characteristic wave height, spectral peak frequency and corresponding peak period, peak wave direction, directional spread, and reflection coefficient. Time series graphs of these parameters, as well as local winds and currents, illustrate some of the salient climatology.

MP CERC-94-7, NTIS No. AD A280 455, "Index and Bulk Parameters for Frequency-Direction Spectra Measured at CERC Field Research Facility, September 1991 to August 1992," Charles E. Long, Janna L. Pemberton, May 1994.

A multiyear series of wind wave frequency-direction spectral measurements has been undertaken at the Field Research Facility of the Coastal Engineering Research Center, U.S. Army Engineer Waterways Experiment Station. Cross-spectra of surface-corrected signals from a spatial array of 15 bottom-mounted pressure sensors have been used in conjunction with an iterative maximum likelihood algorithm to estimate frequency-direction spectra in about 8 m of water, approximately 900 m offshore. This report provides an index of and describes a means of access to 2,779 spectral observations obtained from September 1991 to August 1992. This period represents the sixth year of data collection. In addition to a list of data collection start times, bulk parameters are provided to characterize the observations. Included are characteristic wave height, spectral peak frequency and corresponding peak period, peak wave direction, directional spread, and reflection coefficient. Time series graphs of these parameters, as well as local winds and currents, illustrate some of the salient climatology.

MP CERC-94-8, NTIS No. AD A280 425, "Fisherman's Wharf Breakwater Monitoring Study, San Francisco, California," Jonathan W. Lott, May 1994.

A field monitoring study of the Fisherman's Wharf breakwater was conducted as part of the Monitoring Completed Coastal Projects (MCCP) program. The Corps project referred to as the "Fisherman's Wharf breakwater" in this report consists of a combination of three discrete reinforced concrete sheet-pile structures. The main detached breakwater is an impermeable vertical wall structure with additional support provided by batter piles. The other two structural elements are similar, except that they have openings to allow the passage of tidal flows. The breakwater is located on the north-facing waterfront of the city of San Francisco, California, adjacent to the world-famous Fisherman's Wharf small-craft harbor, bordered by Aquatic Park, Municipal pier, Hyde Street pier, and Pier 45. The site is subject to both local waves from fetches within San Francisco Bay and ocean-generated waves which penetrate to the site via the Golden Gate.

The breakwater was designed primarily to attenuate the damaging short-period waves that are largest from the north to northeast directions. The breakwater also provides protection for the historic ships berthed at Hyde Street pier and allows for expansion and improvement of the commercial fishing berthing facilities. Concurrent requirements were to prevent increases in harbor oscillations (surge) and to permit sufficient tidal circulation to avoid degradation of water quality.

Primary monitoring objectives were to document and evaluate breakwater performance with respect to waves and surge, circulation, scour, littoral processes and deposition, and structural integrity. Prototype measurements of waves and surge, currents, near-structure and harbor bathymetry, and structural alignments were obtained through the MCCP monitoring study. Prototype data were used to evaluate the breakwater's performance and its effects on the site, and to evaluate the procedures and tools, such as physical and numerical models, used to develop the project design.

MP CERC-94-10, NTIS No. AD A281 707, "Selecting Wave Gauge Sites for Monitoring Harbor Oscillations: A Case Study for Kahului Harbor, Hawaii," Michele Okihiro, R. T. Guza, W. C. O'Reilly, David D. McGehee, May 1994.

The U.S. Army Corps of Engineers Field Wave Gauging Program (FWGP) operates a nationwide network of wave gauges and serves as the Corps' central access point for all U.S. wave data. This is the third in a series of FWGP reports describing, through case studies, the process of selecting sites for wave gauges. This report illustrates the use of two different models to optimize gauge sites in a local gauge network for a harbor oscillation study. The harbor that was studied is Kahului Harbor, Hawaii. Results of the numerical model tests show that Kahului Harbor is characterized by numerous resonant modes in the frequency band from 0.001 to 0.12 Hz. Recommendations from this report were followed in deployment of the Kahului Harbor gauge network in October of 1993. The network was installed and is operated by the Ocean Engineering Research Group at the Scripps Institution of Oceanography.

MP CERC-94-11, NTIS No. AD A282 732, "Design of Regional Wave Monitoring Networks: A Case Study for the Southern California Bight," William C. O'Reilly, David D. McGehee, May 1994.

Fundamental considerations in designing wave gauging networks, and an objective method for selecting optimal gauge locations for monitoring coastal wave conditions, are described. The focus is on the spatial variation of wave conditions owing to propagation across the continental shelf and near coastal bathymetry. Generation by local winds and dissipation within the surf zone are not included, so this preliminary work concerns nonbreaking, low-frequency swell waves. Application of the regional network design method is illustrated with an ongoing case study in the Southern California Bight, and the relevance of this work to other sections of the U.S. coastline is discussed. Recommendations for future studies aimed at efficiently expanding the spatial coverage and hence, utility of the present Field Wave Gauging Program, are presented.

MP CERC-95-3, "Literature Review on the Geologic Aspects of Inner Shelf Cross-Shore Sediment Transport," J. Bailey Smith, February 1995.

This report reviews literature concerning the geological aspects of inner continental shelf physical processes, sediment transport, and stratigraphy. Although surf zone and nearshore processes and sediment transport have been extensively addressed in the literature, inner shelf processes and sediment transport, particularly in the cross-shelf direction, are not well understood. Inner continental shelf processes and related cross-shore sediment transport between the beach and inner shelf have important implication for engineering works such as beachfill design and dredged material placement.

Specific topics considered include: depth of closure and extent of sediment transport landward and seaward of this zone; processes that cause cross-shore movement of sediment; amount and physical characteristics of beach material lost to the offshore; long-term fate of sediment that has moved offshore; relationship between depositional structures and flow processes; the impact of episodic storms on sedimentation; and the importance of the geologic framework on the inner shelf. Discussions pertain to the relationships between sediment transport on the inner shelf and the concepts of equilibrium profile, depth of closure, and sedimentation and stratigraphic characteristics of the inner shelf.

Technical Reports

TR CERC-93-18, NTIS No. AD A273 022, "Barbers Point Harbor, Oahu, Hawaii Monitoring Study," Linda S. Lillycrop, Michael J. Briggs, Gordon S. Harkins, Stanley J. Boc, Michele S. Okihiro, September 1993.

This report summarizes the field monitoring program and physical and numerical model studies that have been conducted to date for Barbers Point Harbor, Oahu, HI. This harbor was selected for study as part of the Monitoring Completed Coastal Projects (MCCP) Program in FY 85. The report describes the following: (a) previous physical and numerical model studies conducted in the planning stages of the harbor, (b) state-of-the-art physical and numerical model studies used to estimate harbor response in the existing harbor complex, (c) a field monitoring program for collecting wind wave and long-period waves outside and inside the harbor, (d) intercomparison among previous and current model studies and field data relative to harbor response and deepwater and nearshore coupling between infragravity and wind waves, and (e) evaluation of the effectiveness of the existing rubble-mound wave absorber in dissipating wave energy inside the harbor. Conclusions and recommendations are presented and an extensive appendix containing monitoring program results is provided.

TR CERC-93-19, NTIS No. AD A275 241, "Engineering Design Guidance for Detached Breakwaters as Shoreline Stabilization Structures," Monica Chasten, Julie D. Rosati, John W. McCormick, Robert E. Randall, December 1993.

Detached breakwaters can be a viable method of shoreline stabilization and protection in the United States. Breakwaters can be designed to retard erosion of an existing beach, promote natural sedimentation to form a new beach, increase the longevity of a beach fill, and maintain a wide beach for storm damage reduction and recreation. The combination of low-crested breakwaters and planted marsh grasses is increasingly being used to establish wetlands and control erosion along estuarine shorelines.

This report summarizes and presents the most recent functional and structural design guidance available for detached breakwaters and provides examples of both prototype projects and the use of available tools to assist in breakwater design. Functional design guidance presented includes a review of existing analytical techniques and design procedures, functional design considerations, and data requirements. The chapter on structural design guidance includes static and dynamic breakwater stability and methods to determine performance characteristics such as transmission, reflection, and energy dissipation. Also included is a discussion of numerical and physical modeling as tools for prediction of morphological response to detached breakwaters, and a case example of a breakwater project designed and constructed at Bay Ridge, MD.

TR CERC-94-1, NTIS No. AD A278 532, "Three-Parameter Characterization of Shallow-Water Directional Wind Wave Spectra," Charles E. Long, January 1994.

A 5-year, 6,759-case database of high resolution, shallow-water, frequency direction spectra is examined by classifying spectra in discrete ranges of three parameters: characteristic wave height, spectral peak frequency, and spectral peak direction. Counting the number of cases in each classification reveals the distribution of the spectral population in the three-parameter domain. Averaging spectra within parametric classes defines characteristic spectra that can be used to describe nearshore wave conditions more completely when only three parameters are known or estimated. Though the results are specifically unique to the North Carolina Outer Banks experiment site (the Field Research Facility of the U.S. Army Engineer Waterways Experiment Station Coastal Engineering Research Center), they are illustrative of the variability of wave energy distribution possible in nature. Computation of longshore energy fluxes and radiation stress tensor components using characteristic spectra and the three-parameter guidance of the *Shore Protection Manual* reveals significant differences, and suggests that the ability to measure directional distributions of wave energy with high resolution is critical to the further improvement of modeling and predictive ability.

TR CERC-94-2, NTIS No. AD A278 541, "Storm Evolution of Directional Seas in Shallow Water," Charles E. Long, February 1994.

Measured storm wave frequency-direction spectra are presented to illustrate the evolution of wind wave energy distribution near times of high energy. Twenty-nine storm events, extracted from a 5-year database, are identified and described. Instrumentation consists of a nine-element linear array of bottom-mounted pressure gauges distributed along the 8-m isobath about 900 m offshore of Duck, NC, site of the Field Research Facility (FRF) of the U. S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. Iterative Maximum Likelihood Estimation is used to determine directional distributions of wave energy. Events, identified by elevation and duration of wave energy, are due to both localized storms and long-period swell radiating from major weather events in the distant, deep Atlantic Ocean. Frequency-direction spectra associated with storms known as "northeasters" have a curiously recurrent pattern of broad directional distributions at low frequencies near the spectral peaks and distinct bimodal distributions over a broad range of high frequencies. Reasons for this behavior are not obvious but require clarification because such wave patterns do not conform to conventional models used in engineering design. The differences may lead to substantial variations in design results.

TR CERC-94-3, NTIS No. AD A275 975, "SUPERTANK Laboratory Data Collection Project; Volume I: Main Text," Nicholas C. Kraus, Jane McKee Smith, January 1994.

This report provides information and data documenting a coastal processes project called the SUPERTANK Data Collection Project performed at the O. H. Hinsdale Wave Research Laboratory, Oregon State University, over the period 29 July to 20 September 1991. Objectives of the project were to (a) collect data to verify and improve existing macro-scale beach profile change numerical simulation models, (b) collect data to develop advanced hydrodynamic, cross-shore sand transport, and meso-scale beach profile change numerical simulation models, (c) collect data to quantify performance of sandbars constructed offshore as a beneficial use of dredged material, (d) test and compare sediment-sensing acoustic instruments in a controlled, field-scale environment in support of dredging research, and (e) collect data to improve understanding of micro-scale fluid and sand motion. SUPERTANK was conducted as a multidisciplinary and multi-institutional cooperative effort in which the investigators shared instrumentation and expertise.

TR CERC-94-5, NTIS No. AD A279 878, "Noyo River and Harbor, California, Design for Harbor Entrance Protection; Coastal Model Investigation," Robert R. Bottin, Jr., April 1994.

A 1:75-scale undistorted hydraulic model was used to determine wave conditions at the entrance to Noyo River and Harbor as a result of an offshore breakwater. The impact of the improvements on long-period wave conditions in the harbor as well as wave-induced and riverine bed-load sediment patterns was evaluated. The model reproduced the river from its mouth to a point approximately 15,000 ft upstream, both Noyo Harbor and Dolphin Marina located on the south bank, approximately 3,400 ft of the California shoreline on each side of the river mouth, Noyo cove, and sufficient offshore area in the Pacific Ocean to permit generation of the required test waves. A 45-ft-long wave generator, crushed coal sediment tracer material, and an automated data acquisition and control system were utilized in model operation. It was concluded from the model investigation that:

- Existing conditions are characterized by rough and turbulent wave conditions in the Noyo River entrance. Maximum wave heights ranged from 8.5 to 13.7 ft in the entrance for operational conditions (incident waves with heights of 14 ft or less) and from 12.2 to 15.2 ft for extreme conditions (waves up to 32 ft in height) depending on incident wave direction.
- The offshore breakwater plan will result in maximum wave heights ranging from 6.3 to 9.3 ft in the entrance for operational wave conditions and 8.7 to 14.6 ft for extreme conditions depending on incident wave direction.
- The offshore breakwater plan will not meet the 6.0-ft wave height criterion in the entrance for all incident waves of 14 ft or less (operational conditions). Based on hindcast data, however, the breakwater plan will result in the criterion being achieved 37 percent more of the time than it currently is for existing conditions when operational waves are present. The magnitude of wave heights also will be decreased by about 27 percent as a result of the offshore breakwater for operational waves.
- With no waves present, the offshore breakwater resulted in riverine sediment patterns similar to those obtained for existing conditions except for the 100-year (41,000-cfs) discharge. For this condition, the breakwater prevented material from moving as far seaward in the cove as it did for existing conditions.
- With waves present from west-northwest and west, the offshore breakwater slightly changes the paths of riverine sediment migration and subsequent deposits for some river discharges and does not for others. In general, considering all test conditions, riverine sediment will deposit in an area in the cove between the existing jettied entrance and the proposed structure location, both with and without the breakwater installed.
- The offshore breakwater will not interfere with the migration of wave-induced sediment into the cove for waves from the northwest; however, for waves from the southwest, the breakwater will prevent some sediment from penetrating as deeply shoreward in the cove as it did under existing conditions.
- The offshore breakwater plan will have no adverse impact on surge conditions due to long-period wave energy in Noyo Harbor, Dolphin Marina, and the lower reaches of the river.

TR CERC-94-6, NTIS No. AD A278 555, "Rehabilitation of the South Jetty, Ocean City, Maryland," Gregory P. Bass, Edward T. Fulford, Steven G. Underwood, Larry E. Parson, March 1994.

Frequent dredging requirements and scouring at the foundation of Ocean City Inlet's south jetty resulted in a study to determine the source of shoaling and scouring. The study concluded that sand was being transported northward along Assateague Island, through and over the south jetty, and deposited inside the inlet. Sand was then transported north by ebb currents where it encroached on the Federal navigation channel. A rehabilitation program was initiated to create a littoral barrier to eliminate the shoaling problem and to repair the scour hold. Three headland breakwaters were constructed to stabilize Northern Assateague Island. The site was selected as part of the Monitoring Completed Coastal Projects (MCCP) Program to determine how well the rehabilitation project accomplished its design purpose. The monitoring program extended from October 1986 through January 1989. Activities included beach and offshore surveys, aerial and ground photography of the inlet and adjacent shorelines, inlet hydraulic surveys, nondirectional wave gauging, and side-scan sonar surveys of the scour area. The monitoring program indicated that the south jetty performed as expected. The rehabilitated jetty eliminated the source of material to the shoal area while the headland breakwaters stabilized North Assateague Island. No further erosion within the scour area was observed.

TR CERC-94-7, NTIS No. AD A280 259, "Los Angeles and Long Beach Harbors, Model Enhancement Program, Effects of Wind on Circulation in Los Angeles-Long Beach Harbors," William C. Seabergh, S. Rao Vemulakonda, Lucia W. Chou, David J. Mark, April 1994.

A previously calibrated numerical three-dimensional hydrodynamic model for Los Angeles-Long Beach Harbors, California, was applied to study the combined effects of tide and wind on circulation. The model was calibrated and verified successfully with field data for a summer wind condition. In this report the calibration is compared to a no-wind condition to understand the effects of typical wind conditions on circulation. Also, wind conditions for approaching (winds from the south-east) and passing (winds from the north) frontal systems, typical of fall-winter weather patterns, were simulated. Results indicated the effects of wind can be significant.

TR CERC-94-8, "Wave Conditions for Pier 400 Dredging and Landfill Project, Los Angeles Outer Harbor, Los Angeles, California," Robert R. Bottin, Jr., Hugh F. Acuff, May 1994.

A physical model study, using a 1:100 scale (undistorted) hydraulic model of Los Angeles Outer Harbor, California, was conducted to investigate short-period storm wave conditions for proposed harbor development located near the Angel's Gate entrance. The model reproduced two stages of the proposed Pier 400 dredging and landfill project, Angel's Gate entrance, portions of the existing breakwaters, and sufficient bathymetry in San Pedro Bay to permit proper reproduction of the required test waves. An 80-ft-long electrohydraulic, unidirectional, spectral wave generator and an automated data acquisition and control system were used in model operation.

TR CERC-94-9, "Kings Bay Coastal and Estuarine Physical Monitoring and Evaluation Program: Coastal Studies, Volume I: Main Text and Appendix A," Nicholas C. Kraus, Laurel T. Gorman, and Joan Pope, August 1994.

The objective of this study was to assess the impacts of U.S. Navy-sponsored navigation channel modification and maintenance activities conducted from 1985-1992 on the shoreline in the vicinity of the area traditionally called St. Marys Entrance. This inlet, separating Cumberland Island, Georgia, to the north and Amelia Island, Florida, to the south contains a large estuary, a commercial and recreational port, Fernandina Harbor, Florida, and, since the 1970s, a U.S. Navy submarine base located at Kings Bay, Georgia. A study of the coastal area included the following components:

- Review of historical data and previous studies.
- Numerical simulation of waves and shoreline change.
- Monitoring of waves, water level, shoreline position, beach profile and sediments, and ebb-tidal bathymetry over the period 1988-1992.

No adverse impact on the beaches of Cumberland Island and Amelia Island by U.S. Navy navigation channel modification and maintenance at St. Marys Entrance could be detected in any of the analyses or monitoring in this study.

TR CERC-94-10, "Barking Sands, Kauai, Hawaii, Design of Proposed Harbor for Pacific Missile Range Facility, Coastal Model Investigation," Robert R. Bottin, Jr., August 1994.

A 1:60-scale, three-dimensional hydraulic model was used to investigate the design of a proposed harbor at Barking Sands, Kauai, Hawaii, with respect to wave action and entrance channel shoaling. The model reproduced the proposed harbor, approximately 4,600 ft of the Hawaiian shoreline, and sufficient offshore area in the Pacific Ocean to permit generation of the required test waves. One harbor configuration with two breakwater plans was tested. An 80-ft-long unidirectional, spectral wave generator, an automated data acquisition and control system, and a crushed coal tracer material were used in model operation. It was concluded from test results that:

- For the harbor basin and entrance channel with no structures installed (Plan 1), wave heights in the berthing area will exceed the established 1.5-ft criterion for test waves from all five test directions.
- For the harbor basin and entrance channel with no structures installed (Plan 1), sediment will migrate into the entrance channel for test waves from all five directions.
- For the offshore breakwater plan (Plan 2), wave heights in the berthing area will exceed the established criterion for test waves from the predominant northwest direction.
- For the offshore breakwater plan (Plan 2), sediment tracer north of the harbor will migrate southerly into the entrance channel for test waves from the predominant northwest direction.
- For the dual shore-connected breakwater plan (Plan 3), wave heights will exceed the criterion in the berthing area by only 0.1 ft at one location.
- For the dual shore-connected breakwater plan (Plan 3), no appreciable shoaling of the harbor entrance will occur.

TR CERC-94-11, NTIS No. AD A285 163, "Storm Impact Assessment for Beaches at Panama City, Florida, by Paul D. Farrar, Leon E. Borgman, Lanny B. Glover, Robin D. Reinhard, Joan Pope, Abhimanyu Swain, and Bruce A. Ebersole, September 1994.

Panama City is a heavily developed coastal resort community located on the Florida panhandle which is prone to hurricane and coastal storm damages. This study established a procedure for analyzing short-term storm-induced beach erosion and flooding for the with- and without-project conditions. Storm-induced water level and wave height, period, and direction were numerically modeled for 55 storms representing historical or probable storm events. Beach profile response was then numerically modeled using SBEACH, resulting in a determination of beach recession, wave height, and water level at the shore associated with each storm. Finally, a statistical analysis of the storm and beach response data was performed for use in quantifying benefits associated with the different beach fill alternatives.

TR CERC-94-12, NTIS No. AD A285 121, "Periodic Inspections of Kahului and Laupahoehoe Breakwaters, Hawaii, Report 1, Base Conditions," Dennis G. Markle, Stanley J. Boc, September 1994.

Under the Monitoring of Completed Coastal Projects (MCCP) work unit, Periodic Inspections, past MCCP structures and structures with unique design aspects that have probable applications to other projects are considered for inclusion in a periodic monitoring program. The emphasis of the work is to measure the long-term response of the above-water portions of the structures to their environment. The rubble-mound breakwaters at Kahului Harbor, Maui, Hawaii, and Laupahoehoe Boat Launching Facility, Laupahoehoe Point, Hawaii, are armored with concrete armor unit and concrete rib caps. By means of limited land surveys, low-level helicopter inspections with 35-mm photography, aerial photography, and photogrammetric analysis base conditions have been established for the breakwaters. Now that the base (control) conditions have been defined and a method has been developed to closely compare subsequent years of high-resolution aerial photography of the Kahului and Laupahoehoe breakwaters, these sites will be revisited during future years to gather data by which assessments can be made on the long-term response of the structures to their environment. Insight gathered from these efforts will allow definite decisions to be made based on sound data as to whether or not closer surveillance and/or repair of a structure is required to reduce the chance that it will fail catastrophically.

TR CERC-94-13, NTIS No. AD A "Investigation of Wave Grouping Effects on the Stability of Stone-Armored Rubble-Mound Breakwaters," Robert D. Carver and Brenda J. Wright, September 1994.

High sea waves tend to appear in groups rather than individually. Because of the nature of wave grouping, it appears that it may be an important influence on the stability of rubble-mound structures. The research documented in this report was conducted to obtain a better understanding of the effects of wave grouping on the stability of stone armor when used on breakwater trunks. Results of this study show stability to be influenced by wave period, spectral width, and wave grouping intensity. Levels of wave grouping tested herein are achievable at some, but not all, prototype locations; therefore, results should be applied on a case-by-case basis.

TR CERC-94-14, NTIS No. AD A "Physical and Numerical Model Studies of Barbers Point Harbor, Oahu, Hawaii," Michael J. Briggs, Linda S. Lillycrop, Gordon S. Harkins, Edward F. Thompson, Debra R. Green, September 1994.

The state of Hawaii identified the need for Barbers Point Harbor to accommodate larger ships and increase the number of available berths. Modifications to the harbor were proposed, including widening the entrance channel, and deepening (from 38 to 45 ft) and expanding the harbor basin (an 1,100-ft by 1,100-ft area on the northeast side of the harbor). Physical and numerical (computer) model studies were conducted from September 1990 to June 1992 at the U.S. Army Engineer Waterways Experiment Station to evaluate the technical feasibility and optimize the design of the proposed modifications. In addition to physical and computer model studies, navigation studies were also conducted using a scale model C9 container ship in the physical model.

Recommended modifications to Barbers Point Harbor include flaring of the outer 1,000 ft of the entrance channel from 450 ft wide to 750 ft wide, deepening the channel to 49 ft, constructing a 450-ft jetty along the north side of the entrance channel, deepening the harbor to 45 ft, and dredging a 1,100-ft by 1,100-ft expansion area in the harbor basin.

TR CERC-95-1, NTIS No. AD A "Reef Breakwater Design for Burns Waterway Harbor, Indiana," Hugh F. Acuff, Robert R. Bottin, Jr., February 1995.

A 1:75-scale undistorted hydraulic model was used to evaluate the effectiveness of a proposed segmented reef structure, oriented lakeward of the existing Burns Waterway Harbor breakwater, in reducing wave heights reaching the existing breakwaters. The model reproduced bathymetry which extended to an offshore depth of -46 ft in Lake Michigan, and the proposed reef breakwater was located in water depths ranging from -39 to -41 ft. The total area reproduced in the model was approximately 12,000 sq ft, representing about 3.7 square miles in the prototype. An 80-ft-long electrohydraulic, spectral wave generator and an automated Data Acquisition and Control System were utilized in model operation. It was concluded from the model investigation that (a) the originally proposed reef breakwater plan (Plan 1) will result in excessive wave conditions (in excess of the established 15.0-ft wave height criterion) for 11.6-sec, 19.5-ft incident waves from 0 deg on the leeward side of the proposed reef breakwaters, regardless of its distance from the existing structure, (b) the shoreward toe of the reef breakwater should be located 75-ft lakeward of the existing breakwaters's lakeward toe (this distance provides greater wave protection, with less stone volumes, than the other distances tested), (c) of the reef breakwater configurations tested with the 75-ft crest widths, Plan 4 (275-ft-long reef segments with three westernmost openings closed) was acceptable considering wave heights obtained in the lee of the structure for 11.6-sec, 19.5-ft incident waves from 0 deg, (d) the 75-ft-wide crest of the Plan 4 reef breakwater configuration can be reduced to 70 ft in width (Plan 5) and still provide acceptable wave protection in the lee of the structure for 11.6-sec, 19.5-ft incident wave conditions from 0 deg, (e) the Plan 5 reef configuration (275-ft-long reef segments with three westernmost openings closed and 70-ft crest widths) will result in acceptable wave heights in the existing harbor for 7- to 11.6-sec, 5-ft and 11.6-sec, 13-ft incident wave conditions, (f) considering wave protection provided in the lee of the reef breakwater and in the existing harbor for various incident wave conditions versus volume of construction materials required, the Plan 4 reef breakwater configuration was selected as optimum, based on the plans tested, and (g) the optimum reef breakwater configuration, in conjunction with the existing breakwater (Plan 6), will have no adverse impacts on wave-induced current patterns and/or magnitudes lakeward of the existing structure.

TR CERC-95-2, NTIS No. AD A "Physical Model Study of Revere Beach, Massachusetts," Donald L. Ward, March 1995.

Physical model studies were conducted in 2-D wave flumes to determine overtopping rates for existing and proposed structures along Revere Beach, Massachusetts, during design storm events. Results of the physical model studies were used in regression analysis to develop simple nondimensional equations relating overtopping rates to incident wave conditions and structure design along various reaches of the beach. Total volume overtopping in the physical model was compared to prototype data for a known storm event to verify the model. Overtopping rates were then determined for the existing seawall using bathymetries surveyed both before and after a 1991 beachfill project. The effectiveness of a proposed dike shoreward of the seawall was also measured in the physical model.

WIS Reports

WIS Report 27, NTIS No. AD A "User's Guide to the Wave Information Studies (WIS) Wave Model, Version 2.0," J. M. Hubertz, June 1992.

This report provides guidance on application of the Wave Information Studies Wave Model, Version 2.0 (WISWAVE 2.0), and a description of the upgrades from Version 1.0. The present version operates in all water depths, while the previous version operated only in depths sufficient not to affect wave propagation. The present version also allows for changing water depths during a simulation as would be the case in storm surge applications or regions of large tidal amplitude.

The structure and operation of the model are described. Input necessary to operate the model is described and an example input data set is provided. The theory, equations, and solution techniques contained within the model are described in the references provided. The theory, equations, and solution techniques associated with the upgrade to include shallow-water effects are described in Appendix A. Documented subroutines associated with the upgrade are provided in Appendix B. Comparisons of model results to measurements are provided in WIS reports on the Great Lakes (Reports 22-26) and the Atlantic hindcast (WIS Report 30). WISWAVE 1.0 was used to produce the Great Lakes wave hindcasts described in WIS Reports 22-26. WISWAVE 2.0 was used to produce the Atlantic hindcast, WIS Report 30.

WIS Report 28, NTIS No. AD A "Verification of the Gulf of Mexico Hindcast Wave Information," Jon M. Hubertz and Rebecca M. Brooks, September 1992.

The Wave Information Study (WIS) for the Gulf of Mexico (WIS Report 18) provides a wave climate for the U.S. shorelines of the Gulf of Mexico based on simulation of 20 years of weather data from the period 1956-1975. During these years, few wave data exist with which to evaluate the adequacy of the total hindcast procedure, which includes derivation of pressure charts, translation of these into wind estimates, and then calculation of wave conditions. In 1991, CERC conducted a 1-year hindcast of the Gulf of Mexico for the year 1988 and evaluated the model results against extensive wind and wave measurements now available in order to provide guidance on the quality of the previous hindcast work. This report provides a summary of that hindcast and guidance on the use of the earlier WIS study.

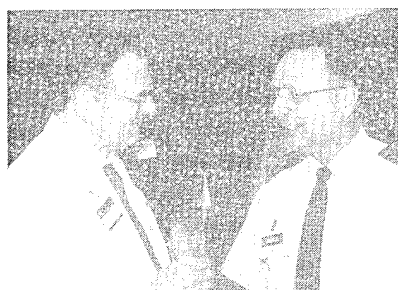
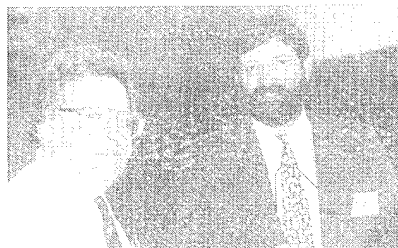
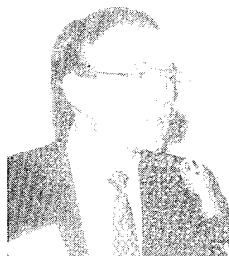
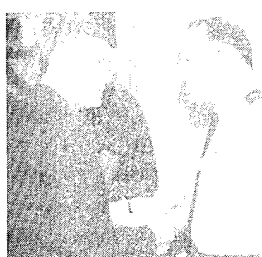
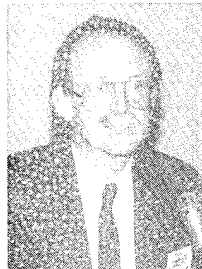
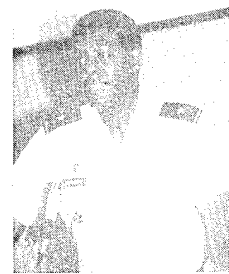
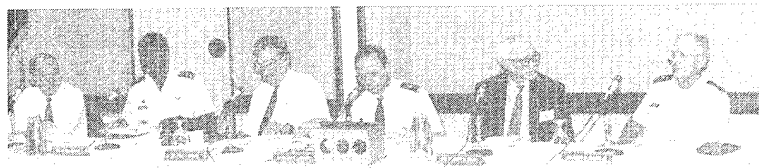
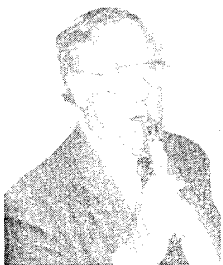
WIS Report 29, NTIS No. AD A "Verification of Pacific Ocean Deepwater Hindcast Wave Information," Jon M. Hubertz, Barbara A. Tracy, Jane B. Payne, and Alan Cialone, December 1992.

The Wave Information Study (WIS) for the Northern Pacific Ocean (WIS Reports 14 and 16) provides a wave climate for the U.S. shorelines of the Northern Pacific based on simulation of 20 years of weather data from the period 1956-1975. During these years few wave data exist with which to evaluate the adequacy of the total hindcast procedure, which includes derivation of pressure charts, translation of these into wind estimates, and then calculation of wave conditions. In 1991, the Coastal Engineering Research Center conducted a 1-year hindcast of the Northern Pacific Ocean for the year 1988 and evaluated the model results against extensive wind and wave measurements now available in order to provide guidance on the quality of the previous hindcast work. This report provides a summary of that hindcast and guidance on the use of the earlier WIS study.

WIS Report 30, NTIS No. AD A "Hindcast Wave Information for the US Atlantic Coast," Jon M. Hubertz, Rebecca M. Brooks, Willie A. Brandon, Barbara A. Tracy, March 1993.

Twenty years of hindcast wind and wave information is summarized for 108 near-shore locations along the US Atlantic coast and for 3 stations along the north coast of Puerto Rico. The procedures to produce this information and examples of verification against measurements are presented. Tables for each station summarized occurrences by month of spectral wave height, peak period, peak mean wave direction, wind speed, and wind direction for categories of 0.5 m, 1.0 sec, 22.5 deg, 2.5m/sec, and 45 deg, respectively. Joint occurrences of height and period for 45-deg direction bands and all directions are presented. Finally, mean heights by month and year and maximum heights by month and year, with associated peak periods and peak mean directions are shown. The 20-year time series of wind and wave information, including spectra at each station, are available from the WIS archive as one-line records every 3 hr. This replaces hindcast information summarized in WIS Reports 2, 6, and 9.

WIS Report 31, NTIS No. AD A "QTS AW (Quick Typhoon Surge and Waves)," Barbara A. Tracy, January 1995. This report is a user's guide for the personal-computer (PC)-based system called QTS AW (Quick Typhoon Surge and Waves). The programs and data to operate this system were developed on a 386 (33-MHz) PC and are included on two computer diskettes. The data set is the storm parameter data for all the typhoons in the Guam area (10 deg by 17 deg N latitude and 141.5 by 148.5 deg E longitude) from 1945-1991. The programs in the system create wind and pressure fields from the input storm data. These wind and pressure fields are then used as input to programs that calculate the wave and surge conditions for the Island of Guam. Several graphical display programs are available for the output results. This system was set up as part of the Wave Information Studies to help meet the needs of the Pacific Ocean Division, U.S. Army Corps of Engineers.



Corps Coastal Workshop

The 1995 Corps of Engineers Regional Coastal Workshop was held in Baltimore, MD, on April 29-30. Attendees included Corps of Engineers representatives from Divisions, Districts, the U.S. Army Engineer Waterways Experiment Station (WES), and Headquarters, U.S. Army Corps of Engineers. The regional workshop had estuary shorelines and navigation channels as a theme. The first day started with an overview of Baltimore District's Tedious Creek breakwater project, followed by a presentation on the FastTABS Model application for tidal circulation by the WES Hydraulics Laboratory. Additional presentations that morning were a presentation by the WES Coastal Engineering Research Center (CERC) on innovative techniques for shoreline pro-

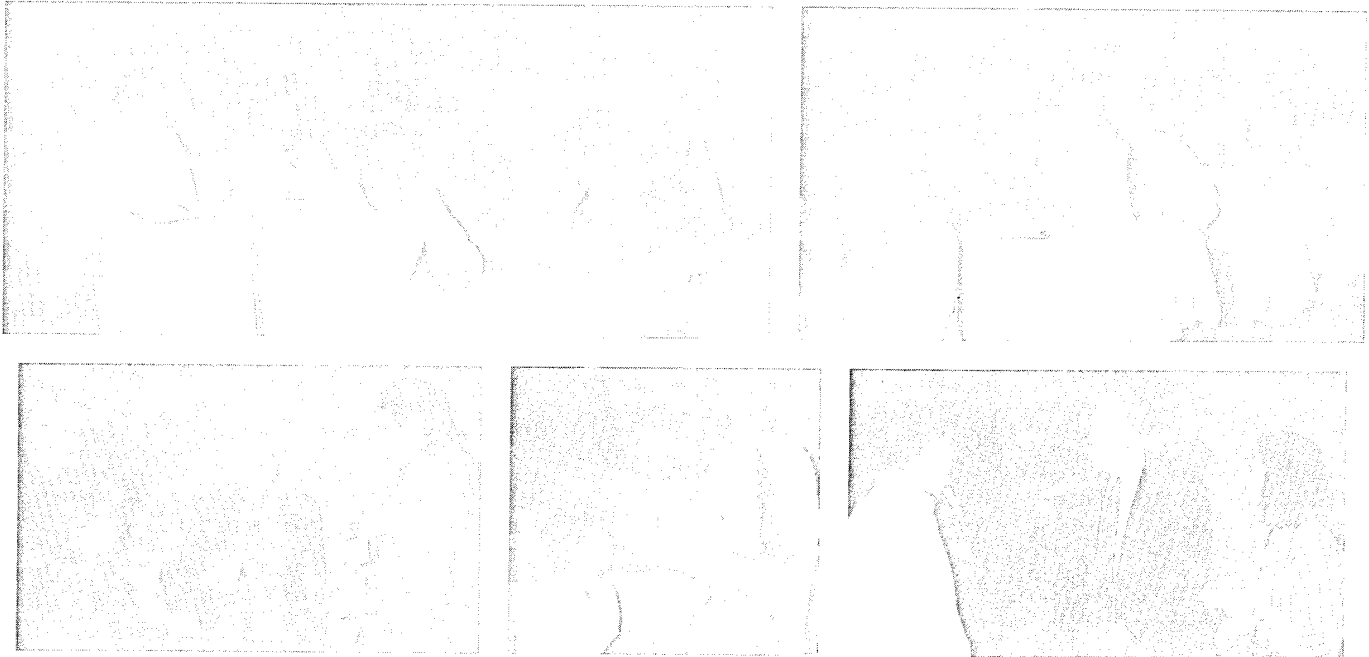
tection, a presentation by Philadelphia District on shoreline change modeling at bay entrances, and presentations by CERC on shoreline change with waves and currents.

Norfolk District led off the afternoon with a presentation on beachfill only plans for estuarine shoreline protection, and this was followed by a CERC panel discussion on runup on beachfills with irregular slopes. The balance of the afternoon was taken up by presentations on sand wave shoaling by Savannah District and CERC, and a presentation on sand wave mitigation in navigation channels by the WES Hydraulics Laboratory.

The second day started with a presentation by Jacksonville District on methods of estimating

storm-induced erosion in estuaries and lakes, followed by a presentation by Philadelphia District on shoreline modeling for estuarine environments, a presentation by the WES Hydraulics Laboratory on sediment dynamics of mud flats, and a presentation by CERC on erosion of sand beaches fronted by mud flats. The remainder of the morning was used for presentations on thin layer dredged material placement by Mobile District and the WES Environmental Laboratory.

An afternoon session on the second day covered ship-generated waves, effects on shorelines and moored vessels, with presentations by South Atlantic Division, the WES Hydraulics Laboratory, and CERC.



Coastal Engineering Geology Class

The 1995 Coastal Engineering Geology Class was held from May 8-12, 1995 at the U.S. Army Engineer Field Research Facility (FRF) at Duck, NC. Twenty-two participants from various U.S. Army Corps of Engineers offices plus two representatives of the National Park Service attended classes concerning Historical Coastal Geology, Coastal Geomorphic Classification, Coastal Morphodynamics, Tidal Inlet Processes and Dynamics, and Techniques of Data Collection and Analysis. The FRF served as an excellent venue to conduct hands-on field measurement exercises including vibracoring, beach surveying, sediment sampling, storm process measurements, and video experiments.

The course was coordinated and instructed by Joan Pope and J. Bailey Smith and instructed by William A. Birkemeier, Kent K. Hathaway, H.C. Miller, Andrew Morang and Donald K. Stauble of the Coastal Engineering Research Center. In addition, William A. Dennis, U.S. Army Engineer District, Wilmington, and Stanley R. Riggs, East Carolina University,



instructed. Dr. Riggs is an expert in the geology of the North Carolina coast and presented topics including geology of the Outer Banks and geological issues associated with land use and project development along the Outer Banks.

The highlight of the class was a field trip to several coastal locali-

ties on the Outer Banks including a perspective from atop the Cape Hatteras Lighthouse and a visit to the site where the North and South Atlantic meet (the tip of Cape Point). The instructors look forward to teaching the next class in 1997, also to be held at the FRF.

Appointment

Mr. Michael J. Briggs, a Research Hydraulic Engineer at the U.S. Army Engineer Waterways Experiment Station (WES) Coastal Engineering Research Center (CERC), has been appointed secretary of the Executive Committee, Waterway, Port, Coastal and Ocean Division, American Society of Civil Engineers. Mr. Briggs joined CERC in 1983, and has been involved in three-dimensional hydraulic modeling, generation,

and analysis of directional wave spectra, and wave transformation in harbors and along coasts. He has served as president of the Vicksburg Branch and Mississippi Section of the American Society of Civil Engineers, as chairman of the Ocean Engineering Technical Committee, and has co-chaired a specialty conference, Civil Engineering in the Oceans V. He is also chairman of the International Association of Hydraulic Research

Working Group on Multidirectional Waves, and President-Elect of the WES Sigma Xi Chapter.

Mr. Briggs holds degrees from the University of Texas at Austin, the University of Southern California, and the Massachusetts Institute of Technology/Woods Hole Oceanographic Institute Joint Program. He is the author or co-author of over 100 technical papers, articles, and reports.

Calendar of Coastal Events of Interest

- Jul 17 - 22, 1995 **Coastal Zone '95**, Tampa, Florida, POC: Dr. Billy Edge, (409) 847-8712, FAX (409) 845-6156, E-Mail: ble1010@sigma.tamu.edu
- Aug 5 - 12, 1995 **International Association for the Physical Science of the Oceans**, General Assembly, Hilton Hawaiian Village, Honolulu, POC: Internet: iapso@oceans.org
- Aug 29 - 31, 1995 **Winds for Wave and Storm Surge Estimation**, Corps of Engineers Workshop, Vicksburg, MS, POC: Ed Thompson, (601) 634-2027
- Sep 4 - 9, 1995 **Coastal Dynamics '95**, Gdansk, Poland, email: cdsec@hancio.ibwpan.gda.pl, FAX: (+4858) 524211
- Sep 6 - 8, 1995 **Meeting, Florida Shore & Beach Preservation Association**, "Political Threats to Beach Preservation" - What Would Happen if the Federal Government Abandoned its Role in Saving America's Beaches? The Breakers Hotel, Palm Beach, Florida, POC: David Tait, (904) 222-7677, FAX (904) 561-1172
- Sep 6 - 8, 1995 **Coastal '95**, Cancun, Mexico, email: cmi@ib.rl.ac.uk
- Sep 18 - 20, 1995 **Remote Sensing for Marine and Coastal Environments**, Seattle, Washington, POC: FAX (313) 994-5123, Internet: wallman@vaxb.erim.org
- Oct 9 - 12, 1995 **MTS/IEEE Oceans '95**, Town and Country Convention Center, San Diego, California, POC: (703) 631-6200
- Oct 18 - 21, 1995 **7th Canadian Coastal Conference**, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada, POC: FAX (902) 426-4104, Internet: solomon@agc.bio.ns.ca, or Internet: tony.bowen@dal.ca
- Oct 26 - 28, 1995 **Estuarine and Coastal Modeling Conference**, San Diego, California, POC: Malcolm Spaulding, (401) 792-2537, FAX (401) 789-1932, or Ralph T. Cheng (415) 354-3358, FAX (415) 354-3363
- Nov 12 - 16, 1995 **Estuarine Research Federation Conference**, Marriott Bayfront, Corpus Christi, Texas, POC: Mary Garrett & Assoc., (512) 888-5400, FAX (512) 888-7401
- Nov 13 - 18, 1995 **Third Seminar on Ports and Inland Waterways**, Hotel Cidade de Goa Beach Resort, Goa, India, POC: PIANC-PCDC Seminar, 32-2-208-5216/18, FAX: 32-2-208-5215
- Nov 14 - 17, 1995 **14th World Dredging Congress**, Amsterdam, The Netherlands
- Nov 20 - 23, 1995 **International Symposium on Ocean Cities**, Monaco, POC: Dr. Jean-Pierre Damiano, E-mail: damiano@alto.unice.fr
- Feb 12 - 16, 1996 **AGU/ASLOS Ocean Sciences Meeting**, San Diego, California, POC: Dr. Suzette Kimball, (404) 331-4916, FAX (404) 331-4943, E-mail: suzette_kimball@nps.gov
- Apr 1 - 2, 1996 **Tsunami 1996**, Hilo, Hawaii, POC: Tsunami Society, PO Box 25218, Honolulu, HI, 96825, E-Mail: gcurtis@uhunix.uhcc.hawaii.edu
- May 6 - 9, 1996 **Offshore Technology Conference**, Houston, Texas, POC: FAX (214) 952-9435, Internet: tech-prog@spelink.spe.org
- Sep 1 - 6, 1996 **25th International Conference on Coastal Engineering**, Peabody Hotel, Orlando, Florida, POC: ICCE '96, (512) 994-2376, FAX: (512) 994-2715, Internet: icce96@cbl.tamucc.edu

Publications of Interest

The following publications are available from the sources indicated. They are not available from CERC.

Floating Breakwaters - A Practical Guide for Design and Construction, PTC II, W.G. 13 (Bulletin 85), 1994, 52 pages; Port Facilities for Ferries - Practical Guide, PTC II, W.G. 11 (Bulletin 87), 1995, 40 pages; and Approach Channels - Preliminary Guidelines, PTC II-30 (Bulletin 87), 1995, 27 pages, prices not listed. Available from PIANC General Secretariat, WTC-Tour 3 - 26^e etage, Boulevard S. Bolivar 30, B-1210 Brussels, Belgium.

Mitigation of Flood and Erosion Damage to Residential Buildings in Coastal Areas, FEMA 257,

34 pages, 1994, Free. Copies available from Federal Emergency Management Agency, Mitigation Directorate, Federal Insurance Administration, 500 C Street, SW, Washington, DC 20472.

Improving Natural Hazards Management on the Oregon Coast: Recommendations of the Coastal Natural Hazards Policy Working Group, 144 pages, 1994, \$12. Copies available from Oregon Sea Grant, Oregon State University, AdS A402, Corvallis, OR 97331-2134, (503) 737-2716, FAX (503) 737-2392.

Hurricanes of 1992, conference proceedings, 820 pages, 1994, \$62. Available from American Society of Civil Engineers, Marketing Services Department, 345 East

47th Street, New York, NY 10017-2398.

Tsunami! The Great Waves in Alaska and Tsunami! The Great Waves on the West Coast, brochures, 1992, free. Copies available from FEMA, Publications Distribution Facility, 8231 Stayton Drive, Jessup, MD 20794, (800) 480-2520, FAX (301) 497-6378.

Coastal Hazards: Perception, Susceptibility, and Mitigation, 386 pages, 1994, \$70; *Coastal Wetland Loss in Louisiana*, 1994, \$15; *Beach/Inlet Processes & Management*, 1995, \$37. Copies available from the Journal of Coastal Research, Business Office, PO Box 1897, Lawrence, KS 66044, (800) 627-0629.

Coastal Engineering Education Program

The next session of the Coastal Engineering Education Program (CEEP) will be held during the 1996-97 academic year starting in August 1996 and ending in August 1997. The CEEP is a one-year program that allows participants to earn a Master of Engineering degree with a concentration of courses in coastal engineering. Students may alternatively enroll in the Master of Science degree program which has slightly different requirements.

The CEEP is offered through the WES Graduate Institute jointly by Texas A&M University (TAMU) and CERC. The first semester is in residence at TAMU, and the second semester and following summer are at CERC. Applicants must have an acceptable score on the Graduate Record Examination and be admitted to Texas A&M University in order to participate in the CEEP. International students are required to take the TOFEL exam and obtain an acceptable score. Action to meet these

requirements should be initiated as soon as possible.

For more information contact Dr. C. H. Pennington, Director, WES Graduate Institute, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, telephone (601) 634-3549, FAX (601) 634-4180, or either Dr. Billy L. Edge or Dr. Robert E. Randall, Ocean Engineering Program, Texas A&M University, College Station, TX 77843-3136, telephone (409) 847-8712 or 845-4515, FAX (409) 862-1542.